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ABSTRACT

The guide is one of a series developed in a pilot project to integrate career education concepts with subject matter in secondary grades. The units are designed to reveal career orientation aspects of traditional topics within five major subject areas: English, social studies, mathematics, science, and health and physical education. The lesson plans are presented in brief outline form, but activities range from those of short duration to several weeks. All provide broad objectives, performance objectives, lesson procedures, and materials and resources in all media. The units in science directed to grades 8-12 cover five activities in electricity and related jobs, weather, the solar system, sea topography, mineralogy, photography as related to physical optics, nuclear chemistry, chemical changes, and machines. (MDW)

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RADFORD CITY SCHOOL'S CAREER EDUCATION PROJECT
RADFORD, VIRGINIA 24141

INTRODUCTION TO SECONDARY CAREER EDUCATION ACTIVITIES

The Career Education Program of the Radford City Schools is a pilot project of research and development for career education techniques and materials. It is funded through a grant from the United States Office of Education which extends until December 14, 1974.

The activity approach was utilized to implement career education concepts on the secondary level. The activities were developed in five major subject areas which include Mathematics, English, Science, Health and Physical Education and Social Studies.

The intent of the activities is to assist in re-focusing traditional subject matter content to the extent that career orientation evolves as the original content is presented.

Some career activities are short in duration while others may consume several weeks.

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RADFORD CITY SCHOOLS CAREER EDUCATION PROGRAM

"ELECTRICITY AND RELATED JOBS"

GRADE: 8 AND 9
SUBJECT: SCIENCE

BROAD OBJECTIVE:

To give the student experiences which will make him more aware of electricity as a major form of energy and more aware of jobs related to it's production and distribution.

PERFORMANCE OBJECTIVE:

The student will be able to explain the law of magnetism.

LESSON PROCEDURE:

1. Student will read "Magnetism as a Force", p. 182-185 in Physical Science for Progress.
2. Student will view filmstrip, "Magnetism".
3. Student will view transparency, "Magnetism and Electricity".
4. Student will view film loop, "What is Magnetism?".
5. Student will perform Experiment One, p. 84, in lab manual, "Discovery Problems in General Science".

MATERIALS AND RESOURCES:

Book:

Pella, Milton O. Physical Science for Progress. Prentice-Hall. Englewood Cliffs, New Jersey, 1970.

Filmstrip:

"Magnetism". General Science.

Transparency:

"Magnetism and Electricity". Singer.

Film Loop:

"What Is Magnetism?" ICF Study Guide.

Lab Manual:

Eckert, Theodore E. Discovery Problems in General Science. College Entrance Book Company. New York, 1971.

RADFORD CITY SCHOOLS CAREER EDUCATION PROGRAM

"ELECTRICITY AND RELATED JOBS"

GRADE: 8 AND 9
SUBJECT: SCIENCE

BROAD OBJECTIVE:

To give the student experiences which will make him more aware of electricity as a major form of energy and more aware of jobs related to it's production and distribution.

PERFORMANCE OBJECTIVE:

The student will be able to explain how a generator produces electricity.

LESSON PROCEDURE:

1. Student will read "Electricity and Magnetism", p. 367-368 in The Physical Sciences, Investigating Man's Environment.
2. Student will view filmstrip, "How Electricity Is Produced".
3. Student will view transparency, "Magnetism and Electricity".
4. Student will view film loop, "Magnetic Fields, part 2".
5. Student will perform Experiments One and Two, p. 91 in lab manual, Discovery Problems in General Science.

MATERIALS AND RESOURCES:

Book:

Fishe and Blecha. The Physical Sciences, Investigating Man's Environment. Laidlaw. River Forest, Illinois, 1971.

Filmstrip:

"How Electricity Is Produced". Singer.

Transparency:

"Magnetism and Electricity". Singer.

Film Loop:

"Magnetic Fields, part 2". ICF Study Guide.

RADFORD CITY SCHOOLS CAREER EDUCATION PROGRAM

"ELECTRICITY AND RELATED JOBS"

GRADE: 8 AND 9
SUBJECT: SCIENCE

BROAD OBJECTIVE:

To give the student experiences which will make him more aware of electricity as a major form of energy and more aware of jobs related to it's production and distribution.

PERFORMANCE OBJECTIVE:

The student will make a report on one of the many job opportunities in the city-owned utility department of the City of Radford, Virginia.

LESSON PROCEDURE:

1. Teacher furnishes a list of utility job positions.
2. Student groups select one position for research. (Duplication should be avoided if possible)
3. Student group may research by interview and use of career and occupational briefs.
4. Student group reports orally to class.

MATERIALS AND RESOURCES:

Occupational and Career Briefs:

Careers. Institute for Research. Chicago, 1971. Research numbers 120, 113, 37.

Chronicle Occupational Briefs. Chronicle Guidance Publications, Inc. Morovia, New York, 1972. Numbers 21, 58, 109, 204, 259, 318, 395.

Resource People:

Will include the city manager, electrical superintendent, the utility service billing manager and the personnel working under them.

RADFORD CITY SCHOOLS CAREER EDUCATION PROGRAM

"ELECTRICITY AND RELATED JOBS"

GRADE: 8 AND 9
SUBJECT: SCIENCE

BROAD OBJECTIVE:

To give the student experiences which will make him more aware of electricity as a major form of energy and more aware of jobs related to it's production and distribution.

PERFORMANCE OBJECTIVE:

Student will explain the relationship between magnetism and electricity by describing the effect of an electric current on a compass needle.

LESSON PROCEDURE:

1. Student will read "Electricity and Magnetism", p. 366-367 in The Physical Sciences, Investigating Man's Environment.
2. Student will view filmstrip, "Magnetism from Electricity".
3. Student will view transparency, "Magnetism and Electricity".
4. Student will view film loop, "Magnetic Fields, part 1".
5. Student will perform Experiment One, p. 87 in lab manual, Discovery Problems in General Science.

MATERIALS AND RESOURCES:

Book:

Fishe and Blecha. The Physical Sciences, Investigating Man's Environment. Laidlaw. River Forest, Illinois, 1971.

Filmstrip:

"Magnetism from Electricity". Singer.

Transparency:

"Magnetism and Electricity". Singer.

Film Loop:

"Magnetic Fields, part 1". ICF Study Guide.

Lab Manual:

Eckert, Theodore E. Discovery Problems in General Science. College Entrance Book Company. New York, 1971.

RADFORD CITY SCHOOLS CAREER EDUCATION PROGRAM

"ELECTRICITY AND RELATED JOBS"

GRADE: 8 AND 9
SUBJECT: SCIENCE

BROAD OBJECTIVE:

To give the student experiences which will make him more aware of electricity as a major form of energy and more aware of jobs related to it's production and distribution.

PERFORMANCE OBJECTIVE:

The student will explain how electricity is measured and sold.

LESSON PROCEDURE:

1. Student will read "Electrical Potential", p. 196-200 in Physical Science for Progress.
2. Student will read "Ohm's Law", p. 202-206 in Physical Science for Progress.
3. Student will view filmstrip, "Ohm's Law of Electrical Resistance".
4. Student will view transparency, "Magnetism and Electricity" (section on Ohm's Law).
5. Student will view film loop, "Ohm's Law".
6. Student will read "Electric Power", p. 211 in Physical Science for Progress.
7. Student will view filmstrip, "Electrical Work, Energy, and Power".
8. Student will view transparency, "Magnetism and Electricity" (section on Watt's Law).
9. Student will listen to a taped explanation of the electrical rate schedule. The tape will be made in an interview with the Utility Service Billing Manager of the city.
10. Student will solve problems in electrical calculations from p. 92, 93, 94 in the lab manual, Discovery Problems in General Science.

MATERIALS AND RESOURCES:

Book:

Pella, Milton O. Physical Science for Progress. Prentice-Hall. Englewood Cliffs, New Jersey, 1970.

MATERIALS AND RESOURCES: (Continued)

Filmstrips:

"Ohm's Law of Electrical Resistance". Singer.
"Electrical Work, Energy, and Power". Singer.

Transparency:

"Magnetism and Electricity". Singer.

Film Loop:

"Ohm's Law". ICF Study Guide.

Resource Person:

Utility Service Billing Manager

RADFORD CITY SCHOOLS CAREER EDUCATION PROGRAM

"SEA FLOOR TOPOGRAPHY WITH EMPHASIS ON CAREER POSSIBILITIES"

GRADE: 9
SUBJECT: EARTH SCIENCE

BROAD OBJECTIVES:

1. To become familiar with the topographic features of the major ocean basins.

2. To become aware of occupations in the field of oceanography.

PERFORMANCE OBJECTIVES:

1. To be able to list and describe features of the sea floor.

2. To be able to read and use topographic maps.

3. To be able to construct relief models from topographic maps.

4. To be able to define and describe various jobs related to the field of oceanography.

LESSON PROCEDURE:

1. Introduce unit on sea floor topography with a film, such as "Earth Beneath the Sea" or "Oceanography - Science of the Sea".

2. Discuss features of ocean basins following text book.

3. Do activity in lab = Construction of a Topographic Profile of the Sea Floor.

4. Discuss topographic profile and how it is used to develop topographic maps.

5. Present basics of topographic maps, using the pamphlet, "Topographic Maps", put out by the U. S. Geological Survey.

6. Do lab exercise "Construction of a Bathymetric Map" from Laboratory Activities in Oceanography. Show film on Mapping.

7. Discuss how relief models can be made from topographic maps.

8. Construct models of the ocean basins with play dough.

9. Have class discussion on careers that use the techniques learned in class or are dependent on information about sea floor topography. (This can be woven into the unit or done separately)

10. Have an activity called "A Future in Marine Science". Set up learning centers around the room using Popeye comic book "Marine Science", filmstrips on Oceanography, filmstrip on

LESSON PROCEDURE: (Continued)

Marine Science, Career Education Cluster Books containing information about careers in oceanography, the tape "Oceanography as a Profession", and possibly a film such as "Challenge of the Oceans". Allow students to circulate to different areas.

11. Career Ideas:

underwater photography
submarine farming, mining
fishing industry (catching to processing)
research and development
government work
laboratories
oil companies
technical writing
weather and space research
ocean ecology
enfironmental protection
navigation
marine engineer
oceanography
map and chart making

MATERIALS AND RESOURCES:

Texts:

ESCP. Investigating the Earth. Houghton-Mifflin, 1968.
Leet and Judson. Physical Geology. Prentice-Hall, 1965.
Stokes and Judson. Introduction to Geology. Prentice-Hall, 1968.
Weyl, Peter K. Oceanography. John Wiley & Sons, Inc., 1970.

Lab Guide:

"Laboratory Studies in Oceanography". Directed Study developed by JoAnne McBath. Copies available on request.

Books:

Arnov, Boris. Homes Beneath the Sea. Little, Brown, 1969.
Briggs, Peter. Men in the Sea. Simon & Schuster, 1968.
Carlisle, Norman. Riches of the Sea. Rev. Ed. Sterling, 1971.
Cowen, Robert C. Frontier of the Sea. Rev. Ed. Doubleday, 1969.
Dugan, James. World Beneath the Sea. National Geographic Society, 1967.
Engel, Leonard. The Sea. Time, 1961.
Koralik, Vladimar. The Ocean World. Holiday, 1966.
Long, E. John, Ed. Ocean Sciences. Banta, 1964.
McKee, Alexander. Farming the Sea. Crowell, 1969.
Paradis, Adrian. Jobs to Take You Places Here and Abroad. McKay, 1968.
Piccard, Jacques. Seven Miles Down. Putnam, 1961.
Weiss, Malcolm E. Man Explores the Sea. Messner, 1969.

MATERIALS AND RESOURCES: (Continued)

Films:

Challenge of the Oceans. 13212
Deep Sea Trawler. 66009
Earth Beneath the Sea. 31812
Fresh Water from the Sea. 24805
Man Invades the Sea. 44112
Map Skills - Using Different Maps Together. 46005
Mapping the Earth's Surface. 55309
Mysteries of the Deep. 59312
Oceanography - Science of the Sea. 41605
Restless Sea. C & P 18012
What is Under the Ocean. 81708

Films are available from Bureau of Teaching Materials, State Department of Education, Richmond, Virginia.

Tapes:

"Oceanography as a Profession". Classroom World Productions 602-2, 1970. (Careers Unlimited)

Filmstrips:

"Landscapes of the Sea". New Portrait of Our Planet. Life.
"Marine Science". Career Education Clusters. Westinghouse Learning Press, 1972.
"Understanding Oceanography". Society for Visual Education, Inc.

Other:

Popeye Comic Book. "Marine Science Careers". King Features, 235 E. 45th Street, New York, New York 10017.
"Topographic Maps". U. S. Geology Survey. Department of Interior.

RADFORD CITY SCHOOLS CAREER EDUCATION PROGRAM

"INVESTIGATING WEATHER PHENOMENA"

GRADE: 9
SUBJECT: EARTH SCIENCE

BROAD OBJECTIVES:

1. To acquire an understanding of weather phenomena.
2. To become familiar with occupations in the field of meteorology.

PERFORMANCE OBJECTIVES:

1. Be able to explain how the atmosphere participates in the water cycle through evaporation, condensation, and precipitation.
2. Be able to determine the relative humidity and dew point, given the temperature and vapor pressure.
3. Compute the height to which moist air must be lifted for condensation to occur, given the temperature and vapor pressure.
4. Distinguish between and be able to identify clouds and explain how they may be formed.
5. Explain how air masses are formed and how they may be modified to become stable or unstable.
6. Describe the life cycle of a frontal cyclone and the typical weather that it produces as its potential energy is converted to kinetic energy.
7. Be able to relate local weather changes to the spatial and temporal pattern of weather movement in general.
8. Be able to discuss the occupation of a meterologist and be familiar with related careers.

LESSON PROCEDURE:

1. Discuss the water cycle in the atmosphere.
2. Do investigation 8-2, "Investigating Evaporation".
3. Discuss evaporation controls, vapor pressure, relative humidity, condensation and adiabatic process.
4. Show film, "Clouds Above".
5. Discuss cloud and precipitation types, their interrelation, and rain formation. (Display Cloud Identification Chart)

LESSON PROCEDURE: (Continued)

6. Show filmstrip on Weather.

7. Do investigation 8-9, "Weather Watch".

8. Collect weather maps and forecasts from newspapers.

9. Show films, "Reading Weather Maps" and "How Weather is Forecast". Discuss career of a meteorologist.

10. Discuss air masses and the development of cyclones.

11. Show film, "Operation Hurricane".

12. Perform Investigation 8-12, "Cumulus Cloud Formation".

13. Perform Investigation 8-13, "Investigating Weather Maps".

14. Show film "Weather Scientists" and conduct a class discussion afterwards on careers in weather science.

15. Invite a meteorologist to speak to the class. Allow time for students to ask questions about his job or related jobs.

MATERIALS AND RESOURCES:

Text:

ESCP. Investigating the Earth. Houghton Mifflin, 1968.

Books:

Atkinson, Bruce W. The Weather Business.
Batton, Lorris J. Harvesting the Clouds. Doubleday, 1969.
Career Opportunities: Ecology, Conservation, and Environmental Control. Ferguson, 1971.
Gaer, Joseph. Everybody's Weather. Rev. Ed. Lippincott, 1957.
Gallant, Roy A. Exploring the Weather. Rev. Ed. Doubleday, 1969.
Halacy, D. S. Weather Changers. Harper, 1968.
Lane, Frank Walter. The Elements Rage. Chilton Books, 1965.
Navarra, John G. Wide World Weather. Doubleday, 1968.
Ross, Frank. Weather. Lothrop, 1965.
Tannehill, Ivan Ray. The Hurricane Hunters. Dodd, 1955.
Thompson, Philip D. Weather. Time-Life Series. Time-Life Books, 1968.
Wells, Robert. Science Hobby Book of Weather Forecasting. Lerner, 1971.
Winchester, James H. Hurricanes, Storms, and Tornadoes. Putnam, 1968.

Films:

Air All About Us. 51704 CORF
Atmosphere and its Circulation. 02604 EBF

Films: (Continued)

Clouds Above. 35105 BAILEY
How Weather is Forecast. 00805 CORF
Hurricane Watch. 24508 USWB
Operation Hurricane. 22909 USWB
Origins of Weather. 04409 EBF
Reading Weather Maps. 96708 CORF
Story of a Storm. 82504 CORF
Thunder and Lightening. 58704 MGHT
Tornado. 24909 USWB
Unchained Goddess. 23312 C&P
Weather Scientists. 67008 UEVA
Weather Station. 33204 MGHT

Films are available from Bureau of Teaching Materials, State Department of Education, Richmond, Virginia.

Chart:

Cloud Identification Chart

Posters:

Newton, David E. "Weather". J. Weston Walch, 1968.

Transparencies:

"Earth - Science - Weather". 3M Company.

Filmstrips:

"Understanding Weather and Climate". SVE.
"Weather". Studies in Science, Set II. Walt Disney Educational Materials Co. (Includes Records)

Career Summaries:

"Meteorologist". Career Summary S-84. Largo, Florida.

RADFORD CITY SCHOOLS CAREER EDUCATION PROGRAM

"STUDY OF THE SOLAR SYSTEM"

GRADE: 9
SUBJECT: EARTH SCIENCE

BROAD OBJECTIVES:

1. To develop the idea of the isolated and generally empty nature of the solar system.
2. To study the individual members of the solar system.
3. To understand the fundamentals of planetary motions according to the law of gravitation.
4. To present modern theories on the origin of the solar system.
5. To provide information on careers in space related fields.

PERFORMANCE OBJECTIVES:

1. To be able to describe verbally or graphically the isolation and relative emptiness of the solar system.
2. To be able to list some known physical characteristics of the various planets and give some reasons for their differences.
3. To be able to describe the general mechanics of the solar system and relate the law of gravitation to planetary motion.
4. To be able to describe the physical characteristics and dynamic properties of the minor members of the solar system.
5. To be able to contrast different theories on the origin of the solar system.
6. To be able to list and describe some careers in the field of space science.

LESSON PROCEDURE:

1. Discuss planetary motion. Do activity with figure 23-1.
2. Show film on Planetary Motion.
3. Do Investigation 23-2, "Motions and Phases of Planet X. Discuss development of knowlege of planetary motion and Kepler's laws of motion.
4. Do Investigation 23-4, "Creating a Model of the Solar System."

LESSON PROCEDURE: (Continued)

5. Discuss major differences between planets, asteroids, meteors and comets. Show film, "Asteroids, Comets and Meteorites".

6. Show filmstrip, "Solar System".

7. Discuss possibilities of life on other planets.

8. Shoe film, "Mars and Beyond".

9. Discuss theories of the origin of the Solar System.

10. Divide class into teams of 3 students. Let each student draw a space-related career out of a hat. The topic should be kept secret and researched by each team. Then the team of 3 students will take turns posing as persons in the specific career, while the rest of the class serves as a panel in a classroom version of "What's My Line". In this way, knowledge of various careers in space science will be presented to the class.

MATERIALS AND RESOURCES:

Text:

ESCP. Investigating the Earth. Houghton-Mifflin, 1968.
Abel. Astronomy.

Books:

Alexander, Tom. Project Apollo. Harper, 1964.
Americans in Space. American Heritage, 1965.
Anderson, Paul. The Infinite Voyage. Crowell-Collier, 1969.
Arnold, Walter M. (Ed.) Career Opportunities for Technicians and Specialists: Engineering Technicians. J. G. Ferguson Publishing Co., 1969.
Asimov, Isaac. Environments Out There. Abelard - Schuman, 1967.
Bergaust, Erik. Space Stations. Putnam, 1962.
Gallant, Roy A. Man's Reach into Space. Doubleday, 1964.
Gatland, Kenneth. Manned Spacecraft. MacMillan, 1967.
Newell, Homer E. Space Book for Young People. 3rd Ed. McGraw, 1968.
Pollack, Philip. Careers and Opportunities in Physics. Dutton, 1959.
U. S. Department of Labor. Occupational Outlook Handbook. 1972-73 Ed.
VonBraun, Wernher. Space Frontier. Holt, 1967.
Wells, Robert. Electronics, Key to Exploring Space. Dodd, 1964.

Films:

Asteroids, Comets and Meteorites. 29605 FA
Earth in Motion. 13101 EBF
Father of Space Age - Robert Goddard. 43808 Hearst

Films: (Continued)

How We Explore Space. 54608 FA
Mars and Beyond. 51012 Disney
Planetary Motion and Space Travel. 08006 Bailey
Planets Around Our Sun. 70408 UEVA
Space Science - An Introduction. 88809 CORF

Films are available from Burear of Teaching Materials, State Department of Education, Richmond, Virginia.

Filmstrips:

"Solar System". Studies in Science, Set II. Walt Disney Ed. Materials Co.

Career Summaries:

"Aircraft Mechanic". Career Brief 621 (5-60) Largo, Florida.
"Aerospace Engineer". Career Brief 002 (0-19.03_ Largo, Florida.
"Aerospace Engineering Technician". Career Summary, S-125 Largo, Florida.
"Astromomer". Career Summary S-99 Largo, Florida.
Career Pamphlets. Aerospace Industries Association of America, 15th and H Streets, N.W. Washington, D. C. 20005.

RADFORD CITY SCHOOLS CAREER EDUCATION PROGRAM

"CAREERS IN EARTH SCIENCE: MINERALOGY"

GRADE: 9
SUBJECT: EARTH SCIENCE

BROAD OBJECTIVES:

1. To learn the properties of important minerals.
2. To relate the properties of minerals to the conditions under which they form.
3. To acquaint students with careers in mineralogy.

PERFORMANCE OBJECTIVES:

1. To be able to identify common minerals by their properties.
2. To be able to discuss the past environment of an area from its mineralogical make-up.
3. To be able to name careers in the field of mineralogy.

LESSON PROCEDURE:

1. Use filmstrip "Rocks and Mineralization" to introduce the properties used in mineral identification. In addition, the transparencies on Rocks and Minerals from 3-M may be used.
2. Give students Mineral Identification Keys and explain their use.
3. Spend several lab periods learning to identify common minerals in classroom.
4. Display posters of common minerals in classroom.
5. Display reference books on minerals.
6. Take a field trip to a local mineral museum or exhibit. Ask curator to speak to group about his job.
7. Ask gem cutter or jeweler to speak to class about how the properties of minerals are used in the jewelry business and about his work.
8. Discuss the formation of minerals under specific conditions using a chart of Bowen's Reaction Series.
9. Discuss the role of a geologist in interpreting the geologic history of an area from it's mineral make-up.

LESSON PROCEDURE: (Continued)

10. Show a film dealing with minerals, such as 'Treasures of the Earth' which stresses conservation of valuable resources, or "Understanding Our Earth - Rocks and Minerals".

11. Discuss careers concerned with minerals. For example, have students think of the different types of jobs in the mining industry, such as: Mining engineering, Prospecting and exploration, Appraisal, Extraction - Open-pit mining, underground mining, drilling, Refinement of minerals, Marketing of minerals, Metallurgical research.

    Other related careers for discussion: Geophysicist, Petroleum Geologist, Jewelry Making and Gem Cutting, Museum Work, Metalworking, Petroleum Engineer, Petroleum Research.

MATERIALS AND RESOURCES:

Text:

ESCP. Investigating the Earth. Houghton-Mifflin, 1968.
Leet and Judson. Physical Geology. Prentice-Hall, 1965.

Books:

Baxter, W. Jewelry, Gem-Cutting, and Metalcraft. 3rd Ed. McGraw, 1966.
Bottley, E. P. Rocks and Minerals. G. P. Putnam's Sons, 1969.
Crescent Books. Gems and Jewels. Orbis Publishing Company, London, 1971.
Dana, E. S. Minerals and How to Study Them. 3rd Ed. Science Editions, John Wiley and Sons, Inc., New York, 1949.
Feirer, John L. General Metals. 3rd Ed. McGraw, 1967.
Gallant, Roy A. Discovering Rocks and Minerals. Natural History Press, 1967.
Gilbert, Miriam. Science Hobby Book of Rocks and Minerals. Lerner, 1971.
Loomis, F. B. Fieldbook of Common Rocks and Minerals. Putnam, 1923.
Ludwig, Oswald A. Metalwork: Technology and Practice. McKnight, 1969.
Pough, Frederick H. A Field Guide to Rocks and Minerals. 3rd Ed. Houghton Mifflin, 1960.
Slade, Edward. Metals in the Modern World. Doubleday, 1967.
U. S. Department of Labor. Occupational Outlook Handbook. 1972-73.

General References:

"Mining". Collier's Encyclopedia. Vol. 16.

Career Summaries:

"Geologists". SRA Occupational Brief. Science Research Association.

Career Summaries: (Continued)

"Mining Engineering". Director of Admissions, Colorado School of Mines, Golden, Col. 80401.
"Mining Engineer". Largo Career Summaries. S-90
"Penetrating New Frontiers With Mineral Engineers". The Society of Mining Engineers. 345 E. 47th Street, New York, New York 10017, 1969.
"Petroleum Engineer". Largo Career Summaries. S-210

Filmstrips:

"Metalworking - Manufacturing II". Set of 6 filmstrips. Acoustifone Career Exploration Series.
"Rocks and Mineralization". SVE (filmstrip and cassette)

Transparencies:

"Rocks and Minerals". 3 M Company, 1966.

Posters:

"Rocks and Minerals". J. Weston Walch, 1966.

Films:

Minerals Challenge. 65612, 1970. (information about the technology of finding and using minerals - good career information)
Rocks and Minerals. 41205, 1965.
Treasures of the Earth. 49304, 1966.
Understanding Our Earth - Rocks and Minerals. 09505, 1958.

Films are available from the Fureau of Teaching Materials, State Department of Education, Richmond, Virginia.

RADFORD CITY SCHOOLS CAREER EDUCATION PROGRAM

"CHEMICAL CHANGES"

GRADE: 11, 12
SUBJECT: CHEMISTRY

BROAD OBJECTIVE:

To develop in the student an understanding of chemical changes, and to develop an awareness of how atoms react during chemical changes and how man uses his knowledge of chemical changes.

PERFORMANCE OBJECTIVE:

1. To be able to describe four types of chemical reactions.
2. Use chemical shorthand in working with chemical formulas and balance equations.
3. Explain the behavior of electrons in a chemical change.
4. Classify various compounds into categories known as acids, bases, salts and oxides.
5. Discuss how man uses his chemical knowledge in and for society.

LESSON PROCEDURE:

1. Show the film "Chemical Changes are About Us".
2. Devise a lecture about chemical changes and present it to the class, afterwhich a work sheet involving formula writing will be handed out for the students to complete.
3. Three labs involving chemical changes will be assigned to students. These labs will include (1) production and collection of oxygen (2) titration of an acid with a base (3) mixing of solutions to form a precipitate.
4. Play the tape "Chemistry As A Profession" and conduct classroom discussion afterwards.

MATERIALS AND RESOURCES:

Texts:

Cotton and Lynch. Chemistry: An Investigative Approach. Houghton Mifflin, 1970.
Duel, Metcalfe and Williams. Modern Chemistry. Holt, Rinehart and Winston, 1958.
Fisk and Blecha. The Physical Sciences. Laidlaw Brothers, 1971.

MATERIALS AND RESOURCES: (Continued)

Books:

Buler, Nelson. Experiments in Chemistry. Crowell, 1952.
Coulson, E. Test Tubes and Brakers; Chemistry for Young Experimenters. Doubleday, 1971.
Dillard, Clyde. Chemistry: Reactions, Structures and Properties. MacMillan, 1971.
Farago, Peter. Introduction to Chemistry. Arco, 1965.
Freeman, Ira. All About Wonders of Chemistry. Random, 1954.
Freeman, Mae. Fun With Chemistry. Random, 1962.
Gallant, Roy. The ABC's of Chemistry. Doubleday, 1963.
Goostray, Stella. Experiments in Applied Chemistry. Macmillan, 1966.
Occupational Outlook Handbook, 1972-73. U. S. Department of Labor.
Sackheim, George. Chemistry For the Health Sciences. Macmillan, 1973.
Vaczek, Louis. The Enjoyment of Chemistry. Viking, 1964.
Woodburn, John. Excursions Into Chemistry. Lippincott, 1965.

Films:

The following films may be acquired from The Bureau of Teaching Materials, State Department of Education, Richmond, Virginia:

"Chemical Change". 64208, 1960
"Chemical Changes All About Us". 64208, 1960
"Simple Changes in Matter". 17704, 1953

Filmstrips:

"Chemistry Series". McGraw Hill.
"The Chemistry of Iron". American Iron and Steel Institute.

Tapes:

"Chemistry As A Profession". Classroom World Productions, 1970.

Film Loops:

84-0231 "Reaction Rates". R. M. Whitney Roxbury Latin School. Cambridge, Mass. (NDEA), 1968.

RADFORD CITY SCHOOLS CAREER EDUCATION PROGRAM

"NUCLEAR CHEMISTRY"

GRADE: 11 and 12
SUBJECT: CHEMISTRY

BROAD OBJECTIVES:

1. To develop an understanding of the nature, types, general properties and detection of radioactivity and to study representative uses of nuclear energy.

2. To gain an understanding of the emerging importance of nuclear chemistry in today's society and acquaint the student with careers relating to this field.

PERFORMANCE OBJECTIVES:

1. List the different types of radiation and explain the behavior of each type.

2. Explain how the various types of radiation can be detected.

3. Describe a nuclear reactor and the reactions which occur inside a reactor.

4. Diagram a decay chain.

5. Explain in detail how radioactive materials are used to treat diseases.

6. State some hazards and some benefits to health that can occur through the use of radioactive substances.

7. To be able to expound on the career opportunities in nuclear chemistry.

LESSON PROCEDURE:

1. Have a lecture which covers the basics of nuclear chemistry.

2. Show a film about Nuclear Structure.

3. Have the students construct a model of a nuclear reactor by using boxes, tubes, wires, and cans. Discuss the function of the various parts. Explain the steps in the conversion of nuclear energy to electrical energy.

4. Compare the advantages and disadvantages of nuclear energy with the energy produced by the burning of coal, oil or gas.

5. Have students construct a bulletin board display to illustrate the fission of uranium 235. Use styrofoam balls of various sizes and colors to represent nutrons and atoms.

LESSON PROCEDURE: (Continued)

6. Allow students time to visit the library to acquire information concerning careers in nuclear chemistry.

MATERIALS AND RESOURCES:

Texts:

Cotton and Lynch. Chemistry = An Investigative Approach. Houghton Mifflin, 1970.
Duel, Metcalfe and Williams. Modern Chemistry. Holt, Rinehart and Winston, Inc., 1968.
Fish and Blecha. The Physical Sciences. Laidlaw Brothers, 1971.
Williams, Metcalfe, Trinklein and Lefler. Modern Physics. Holt, Rinehart and Winston, Inc., 1968.

Books:

Asimor, Isaac. The Neutrino. Doubleday, 1966.
Cohen, Bernard. Heart of the Atom. Doubleday, 1967.
Davis, George. Radiation and Life. Iowa State University Pr. 1967.
Halacy, Daniel. Radiation, Magnetism and Living Things. Holiday, 1966.
Hillman, Hal. High Energy Physics. Lippincott, 1968.
Kogan, Philip. The Cosmic Power; Foundations of Nuclear Physics. Ginn, 1966.
McKnown, Robin. The Fabulous Isotopes. Holiday, 1962.
Occupational Outlook Handbook. 1972-73, U. S. Department of Labor.
Poole, Lynn. Carbon - 14 and Other Science Methods That Date the Past. Graw, 1961.

Films: The following films may be acquired from The Bureau of Teaching Materials, State Department of Education, Richmond, Virginia.

"Nuclear Fallout-Fiction and Fact". 27305, 1963.
"Nuclear Structure". 33209, 1957.
"Radioactivity". 74708, 1961.
"Radiological Defense". 33612, 1961.

Posters:

"Nuclear Energy and Environment". Atomic Energy Commission.

Filmstrip:

"Jobs In Health Service" Coronet Instructional Films, 1971.

Tapes:

"Nuclear Technician" Eye Gate, 357C, 1972.
"Scientific Research". Classroom World Productions, 1970.

RADFORD CITY SCHOOLS CAREER EDUCATION PROGRAM

"MACHINES"

GRADE: 12
SUBJECT: PHYSICS

BROAD OBJECTIVE:

To introduce students to the power and energy saving machines and the related careers.

PERFORMANCE OBJECTIVES:

1. To be able to demonstrate the transformation of energy through the use of machines in the lab setting.

2. To list some careers which incorporate power and energy saving machines.

LESSON PROCEDURE:

1. Lecture to students about machines.

2. Use 16 mm film on "Simple Machines".

3. Have several lab periods which require the use of machines to transform energy.

4. Give students the assignment of building a model bridge. Have them organize a construction company and delegate responsibilities.

5. Ask a civil engineer from the community to speak to the class about career opportunities.

MATERIALS AND RESOURCES:

Text:

Williams, Metcalfe, Trinklein and Lefler. Modern Physics. Holt, Rinehart and Winston, Inc., 1968.

Books:

"Civil Engineers". Occupational Outlook Handbook. U. S. Department of Labor, 1972-73.
Meyer, Jerome, Machines. World Publishers, 1958.
Robbins, Paul H. "Engineering". Hophe, William E. The Encyclopedia of Careers and Vocational Guidance. Doubleday and Company, Inc., 1972.

Films:

Simple Machines 43804, 1942. Educational Motion Pictures for Virginia's Public Schools. Bureau of Teaching Materials, State Department of Education, Richmond, Virginia.

Films: (Continued)

Machines Do Work. 26204, 1958. Educational Motion Pictures for Virginia's Public Schools. Bureau of Teaching Materials, State Department of Education, Richmond, Virginia.

Tapes:

Construction. Classroom World Productions, 1970.
Engineering. Classroom World Productions, 1970.

Film Loops:

All-Around Machinists. Encyclopedia Britannica Ed. Corp., 1969.
Machining Occupations Electronics. Encyclopedia Britannica Educational Corporation, 1970.
Operating Engineers. Encyclopedia Britannica Educational Corporation, 1970.
Surveyors. Encyclopedia Britannica Educational Corporation, 1969.

Sound Filmstrips:

Machinists. ("Age of Electronics" Series) Bowmar, 1970.
The Work of Simple Machines. SVE Educational Filmstrips.

Pamphlets: (All from Careers, Inc., Largo, Florida)

"Civil Engineer". Career Brief, Largo, Florida.
"Civil Engineering Technician". Career Brief, Largo, Florida.
"Mechanical Engineer". Career Brief, Largo, Florida.
"Operating Engineers". Career Brief, Largo, Florida.

Resource Persons:

Engineers from the community.

RADFORD CITY SCHOOLS CAREER EDUCATION PROGRAM

"PHOTOGRAPHY AS RELATED TO PHYSICAL OPTICS"

GRADE: 12
SUBJECT: PHYSICS

BROAD OBJECTIVES:

1. To expose the students to the principles of physical optics and answer the question, "Why and how does the camera work?".

2. To acquaint the students with careers related to photography.

PERFORMANCE OBJECTIVES:

1. To acquire an understanding of the laws of reflection and refraction of light.

2. To define images and list the two types.

3. To be able to list the basic parts of a camera,to tell their functions and the principles upon which these parts operate.

4. To list some of the careers associated with photography.

LESSON PROCEDURE:

1. Discuss and explain the concept of physical optics.

2. Design four labs which operate on a rotating basis. Each student will complete all four labs by the end of a designated time.

   Lab 1 - Discuss and demonstrate the formation of images by use of the pinhole camera.
   Lab 2 - Exhibit types of mirrors and develop diagrams for plane and curved surfaces.
   Lab 3 - Set up apparatus to demonstrate converging and diverging lenses.
   Lab 4 - Examine a camera which has been disassembled.

3. Show films which deal with the subject of light.

4. Create learning centers which display information about cameras, developing techniques and basic movie making techniques.

5. Show filmstrip entitled "Careers in Photography".

MATERIALS AND RESOURCES:

Text:

Williams, Metcalfe, Trinkleir & Lefler. Modern Physics. Holt, Rinehart and Winston, Inc., 1968.

Books:

Asher, Harry. Photographic Principles and Practices. Chilton Book Co., Philadelphia, 1968.
Feininger, Andrea. Successful Photography. Prentice-Hall, 1954.
Forsee, Aylesa. Famous Photographers. Macrae, 1968.
Gramet, Charles. Light and Sight. Avelaro, 1963.
Keppler, Victor. Your Future in Photography. Arco., 1971.
Meyer, Jerome. Prisms and Lenses. World Publishers, 1959.
Mueller, Conrad. Light and Vision. Time, Inc., 1966.
Neal, Charles. Exploring Light and Color. Childrens, 1964.
Occupational Outlook Handbook, 1972-73. U. S. Department of Labor.
Ruchlis, Hy. Wonder of Light. Harper, 1960.
Tannenbaum, Buelah. Understanding Light. McGraw, 1960.

Films:

The follosing films may be acquired from The Bureau of Teaching Materials, State Department of Education, Richmond, Virginia.

"Light All About Us". 01805, 1954.
"Light and Color". 88808, 1963.
"Light and Its Story". 66408, 1961.
"Light Lenses". 96004, 1952.
"Light - Let Us Talk About It". 56809, 1969.
"Light - Refraction". 95904, 1952.
"Light - Spherical Mirrors". 95804, 1950.
"Light - Wave and Quantum Theories". 88309, 1970.
"Light Waves and Their Uses". 93304, 1937.
"Introduction to Optics". 22312, 1963.
"Science of Light". 06005, 1961.

Tapes:

"Photography". Classroom World Productions, 1970.

Filmstrips:

"Photography - A History". Educational Dimensions Corporation.
"Photography As A Profession". Educational Dimensions Corp.

Pamphlets:

"Adventures in Existing-Light Photography". Eastman Kodak Company, 1969.
"Basic Developing, Printing and Enlarging". Eastman Kodak Company, 1972.
"Color As Seen and Photographed". Eastman Kodak Company, 1966.
"Color Photographs Outdoors". Eastman Kodak Company, 1960.
"Kodak Master Photoguide for Still Picture Taking". Eastman Kodak Company, 1968.
"Professional Printing in Black and White". Eastman Kodak Company, 1968.